

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

0559-0110P

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

10/049597

INTERNATIONAL APPLICATION NO.

PCT/FR00/02398

INTERNATIONAL FILING DATE

August 29, 2000

PRIORITY DATE CLAIMED

August 30, 1999

TITLE OF INVENTION

METHOD FOR OBTAINING A RADIOGRAPHIC IMAGE OF A TOOTH AND OF ITS SURROUNDING ENVIRONMENT,
AND DEVICES IMPLEMENTING SAID METHOD

APPLICANT(S) FOR DO/EO/US

MOUYEN, Francis

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39 (1).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau. WO 01/15603
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is transmitted herewith.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98, Form PTO-1449(s), and International Search Report (PCT/ISA/210) with 6 cited document(s).
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
 - 1.) PCT/IB/304 and PCT/IB/308
 - 2.) PCT Substitute Claims Letter w/ PCT/IPEA/409
 - 3.) One (1) sheet of Formal Drawings

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) <div style="font-size: 2em; font-weight: bold;">10/049597</div>	INTERNATIONAL APPLICATION NO. PCT/FR00/02398	ATTORNEY'S DOCKET NUMBER 0559-0110P
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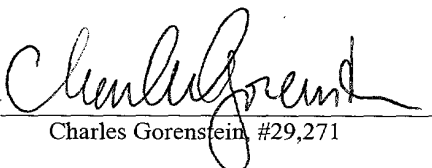
21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. \$1,040.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO. \$740.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4). \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY		
				\$	890.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	0	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE			
Total Claims	21 - 20 =	1	X \$18.00	\$	18.00	
Independent Claims	1 - 3 =	0	X \$84.00	\$	0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable) Yes + \$280.00				\$	280.00	
TOTAL OF ABOVE CALCULATIONS =				\$	1188.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$	0	
SUBTOTAL =				\$	1188.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	0	
TOTAL NATIONAL FEE =				\$	1188.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$	40.00	
TOTAL FEES ENCLOSED =				\$	1228.00	
				Amount to be: refunded	\$	
				charged	\$	

- a. ☒ A check in the amount of \$ **1228.00** to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account. No. _____ in the amount of \$ _____ to cover the above fees.
 A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
 overpayment to Deposit Account No. 02-2448.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:
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Date: February 14, 2002

By 
 Charles Gorenstein, #29,271

PATENT
0559-0110P

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant: MOUYEN, Francis
Int'l. Appl. No.: PCT/FR00/02398
Appl. No.: New Group:
Filed: February 14, 2002 Examiner:
For: METHOD FOR CONTAINING RADIOGRAPHIC IMAGE OF A
TOOTH AND ITS SURROUNDING ENVIRONMENT, AND
DEVICE FOR IMPLEMENTING SAID METHOD

PRELIMINARY AMENDMENT

BOX PATENT APPLICATION

Assistant Commissioner for Patents
Washington, DC 20231

February 14, 2002

Sir:

The following Preliminary Amendments and Remarks are
respectfully submitted in connection with the above-identified
application.

AMENDMENTS

IN THE TITLE:

Please amend the title to read as follows:

--METHOD FOR OBTAINING A RADIOGRAPHIC IMAGE OF A TOOTH AND
IT SURROUNDING ENVIRONMENT, AND DEVICES IMPLEMENTING SAID
METHOD--

IN THE ABSTRACT OF THE DISCLOSURE:

Please replace the Abstract of the Disclosure with the rewritten Abstract of the Disclosure located on a separate sheet attached hereto.

IN THE SPECIFICATION:

Please amend the specification as follows:

Before line 1, insert --This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/FR00/02398 which has an International filing date of August 29, 2000, which designated the United States of America.--

IN THE CLAIMS:

Please amend the claims as follows:

3. (Amended) Method according to claim 1 or 2, characterized in that said light rays are converted into analogue electrical signals, and in that these said analogue electrical signals are converted into digital electrical signals.

4. (Amended) Method according to claim 1, characterized in that it comprises amplifying at least one portion of said electrical signals according to a predetermined function.

5. (Amended) Apparatus for accomplishing the method according to claim 1, characterized in that it comprises:

a source (1), which is capable of emitting a bundle of X-rays towards said tooth (4) and its surrounding area (5),

a plurality of cylindrical rods (10), which are produced from a material capable of transforming the X-rays into light rays (11) of a wavelength greater than that of the X-rays, each rod comprising an inlet face (12), which is capable of receiving said X-rays, and an outlet face (13), which is capable of emitting said light rays (11), said cylindrical rods (10) being disposed side by side so that all of the inlet faces (12) are turned towards said X-ray source (1),

means (20) for converting light rays (11) into electrical signals,

means (30) for connecting the outlet faces (13) of the cylindrical rods to said means (20) for converting light rays into electrical signals comprising a bundle of optical fibres, and

means (70) for processing said electrical signals with a view to producing said radiographic image.

11. (Amended) Apparatus according to claim 5, characterized in that the means (70) for processing said electrical signals with a view to producing said radiographic image comprise at least one of the following elements: a temporary memory, a permanent memory or a converter for converting electrical signals into video signals which are capable of being displayed on a screen.

12. (Amended) Apparatus according to claim 5, characterized in that said cylindrical rods (10) are produced from caesium iodide crystal.

14. (Amended) Apparatus according to claim 5, characterized in that said cylindrical rods (10) are in contact with one another to form a mosaic.

REMARKS

The specification has been amended to provide a cross-reference to the previously filed International Application.

The claims have been amended to delete improper multiple dependencies and to place the application into better form for examination. An Abstract of the Disclosure has been added due to it being omitted during translation of the International Application. The title has been amended to correspond with the title on the declaration.

Entry of the above amendments is earnestly solicited. An early and favorable first action on the merits is earnestly solicited.

Attached hereto is a marked-up version of the changes made to the application by this Amendment.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By 
Charles Gorenstein, #29,271

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Attachment: VERSION WITH MARKINGS TO SHOW CHANGES MADE

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE TITLE:

The title has been amended as follows:

METHOD OF OBTAINING A RADIOGRAPHIC IMAGE OF A TOOTH AND IT
SURROUNDING [AREA]ENVIRONMENT, AND [APPARATUSES WHICH PERMIT ITS
METHOD TO BE ACCOMPLISHED]DEVICES FOR IMPLEMENTING SAID METHOD

IN THE ABSTRACT OF THE DISCLOSURE:

An Abstract of the Disclosure has been added.

IN THE CLAIMS:

The claims have been amended as follows:

3. (Amended) Method according to [one of the preceding
claims]claim 1 or 2, characterized in that said light rays are
converted into analogue electrical signals, and in that these
said analogue electrical signals are converted into digital
electrical signals.

4. (Amended) Method according to [one of the preceding
claims]claim 1, characterized in that it comprises amplifying at
least one portion of said electrical signals according to a
predetermined function.

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5. (Amended) Apparatus for accomplishing the method according to [on of the preceding claims]claim 1, characterized in that it comprises:

a source (1), which is capable of emitting a bundle of X-rays towards said tooth (4) and its surrounding area (5),

a plurality of cylindrical rods (10), which are produced from a material capable of transforming the X-rays into light rays (11) of a wavelength greater than that of the X-rays, each rod comprising an inlet face (12), which is capable of receiving said X-rays, and an outlet face (13), which is capable of emitting said light rays (11), said cylindrical rods (10) being disposed side by side so that all of the inlet faces (12) are turned towards said X-ray source (1),

means (20) for converting light rays (11) into electrical signals,

means (30) for connecting the outlet faces (13) of the cylindrical rods to said means (20) for converting light rays into electrical signals comprising a bundle of optical fibres, and

means (70) for processing said electrical signals with a view to producing said radiographic image.

11. (Amended) Apparatus according to [one of claims 5 to 10]claim 5, characterized in that the means (70) for processing said electrical signals with a view to producing said radiographic image comprise at least one of the following

elements: a temporary memory, a permanent memory or a converter for converting electrical signals into video signals which are capable of being displayed on a screen.

12. (Amended) Apparatus according to [one of claims 5 to 11] claim 5, characterized in that said cylindrical rods (10) are produced from caesium iodide crystal.

14. (Amended) Apparatus according to [one of claims 5 to 13] claim 5, characterized in that said cylindrical rods (10) are in contact with one another to form a mosaic.

ABSTRACT OF THE DISCLOSURE

The invention concerns methods and devices for obtaining a radiographic image of a tooth and its surrounding environment. The method and the device are essentially characterized in that cylindrical rods produced from a material capable of transforming X-rays into light rays are arranged side by side for receiving the X-rays emitted by a source after they have passed through the tooth and its surrounding environment so as to both guide them and transform them into light rays, means thereafter converting said light rays into electric signals which are processed to produce the radiographic image.

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METHOD OF OBTAINING A RADIOGRAPHIC IMAGE OF A
TOOTH AND OF ITS SURROUNDING AREA AND APPARATUSES
WHICH PERMIT THIS METHOD TO BE ACCOMPLISHED

The invention relates to the techniques of dental radiology and concerns, more particularly, the methods of obtaining a radiographic image of a tooth and of its surrounding area, as well as the apparatuses for permitting these methods to be accomplished.

The evolution of electronics seen in these last years has permitted the techniques for radiological examinations of organs of the human body to be improved significantly. The aim of this evolution is, more particularly, to reduce, for the patient and for the operative, the doses of exposure to the X-rays while improving the image quality of the X-rayed target. The methods and the apparatuses described and illustrated in the French patents published under the numbers 2 333 404, 2 378 496, 2 415 938, 2 495 429, 2 476 949, 2 477 626, 2 479 636, 2 185 667, 2 247 749 and 2 310 059 demonstrate this state of affairs well.

The techniques of dental exploration have themselves remained at the traditional stage of radiography, which comprises inserting the tooth to be examined between an extra-buccal source of X-rays and an intra-buccal radiographic film sensitive to the X-rays which traverse the irradiated tooth. The forms of the image obtained on this radiographic film correspond to the shadows borne by the constituents which are more or less opaque to the X-rays of the examined tooth. Although this technique of dental radiography is the most common at the present time, it has the disadvantage, however, of limiting the number of plates, taking into account the X-ray doses which they require.

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It is useful to specify that the new techniques of radiology have involved, more particularly, the intrinsic ability of the sensor of the bundle of X-rays emerging from the irradiated target in order, as has been mentioned above, to reduce the times of exposure to the X-rays, while improving the image quality of the X-rayed target. In addition, the image is obtained in real time, thereby avoiding the manipulations in developing the film of traditional dental radiography.

Such apparatuses are already known, for example the one which is described and illustrated in American Patent No. 4 160 997 (SCHWARTZ).

The intra-buccal sensor described in this American patent has numerous disadvantages, however, in particular the major disadvantage of not being able to fulfil its essential function which comprises recording the bundle of X-rays emerging from an irradiated tooth and to provide therefrom information capable of being analysed by an electronic processing unit, and this being in order to reveal, on the monitor of a display channel, the image of the aforesaid tooth. In fact, to understand that this intra-buccal sensor is not functional, it is useful to recall that the apparatuses for transferring charges have the following characteristics:

- the dimensions of their sensitive face are not sufficient to detect all of the X-rays of a bundle emerging from an irradiated tooth, and SCHWARTZ propose to use, in their intra-buccal sensor, a screen which ensures a linear transmission,
- their sensitive face deteriorates under the impact of X-rays of greater power than 1 KeV, and the screen belonging to SCHWARTZ does not ensure sufficient protection for this sensitive face,

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the unit for the electronic processing of the electrical information coming from the charge-transferring apparatus does not have to be further away from the latter than twenty centimetres, this distance being the limit beyond which the output signal is too weak to be processed, and the unit for electronically processing the information at the output by of the SCHWARTZ intra-buccal sensor is extra-buccal and connected thereto by a cable longer than twenty centimetres.

Drawing up the balance sheet for this state of affairs, the Applicants carried out research which ended in the manufacture of an apparatus which permits a dental radiological image to be obtained on a monitor of a display channel and the aforementioned disadvantages to be overcome, in order to provide a functional apparatus with indisputable performance in the quality of reproduction of the dental image and in the reduction of the amount of exposure to the X-rays. The Applicants have already filed a patent application in this field, the application EP 0 129 451.

The present invention is the up-to-date result of their studies in the field. Its object is to improve the known methods of prior art to obtain a radiographic image of a tooth and of its surrounding area, as well as apparatuses which permit these methods to be accomplished.

More precisely, the present invention relates to a method of obtaining a radiographic image of a tooth and of its surrounding area, characterised in that it comprises:

emitting a bundle of X-rays in the direction of said tooth and its surrounding area,

guiding the X-rays, which emerge from said tooth and its surrounding area, in substantially cylindrical volumes substantially along the axis of said volumes,

transforming the X-rays, when they are guided in said cylindrical volumes, into light rays of a greater wavelength than that of the X-rays,

converting these light rays into electrical signals, and

processing these electrical signals to produce said radiographic image.

The present invention also relates to an apparatus for accomplishing the above method, characterised in that it comprises:

a source, which is capable of emitting a bundle of X-rays towards said tooth and its surrounding area,

a plurality of cylindrical rods, which are produced from a material capable of transforming the X-rays into light rays of a wavelength greater than that of the X-rays, each rod comprising an inlet face, which is capable of receiving said X-rays, and an outlet face, which is capable of emitting said light rays, said cylindrical rods being disposed side by side so that all of the inlet faces are turned towards said X-ray source,

means for converting light rays into electrical signals,

means for connecting the outlet faces of the cylindrical rods to said means for converting light rays into electrical signals, and

means for processing said electrical signals with a view to producing said radiographic image.

Other features and advantages of the present invention will appear in the course of the following description, given by way of example but in no way limiting, with reference to the accompanying drawing, in which:

The single Figure is the basic diagram of an apparatus according to the invention to obtain a radiographic image of a tooth and its surrounding area.

The present invention relates to a method of obtaining a radiographic image of a tooth and of its surrounding area, that is to say the gum portion in which the tooth is implanted, possibly even the jawbone, the possible cavities which such a tooth may comprise, filled or not with an amalgam or the like, etc.

The method essentially comprises emitting a bundle of X-rays in the direction of the tooth and its surrounding area. The X-rays, which emerge from the tooth and its surrounding area, are guided in substantially cylindrical volumes substantially along the axis of these volumes, while being transformed into light rays of a much greater wavelength than that of the X-rays, and such wavelength being selected so as to permit the conversion of these light rays into electrical signals.

The method finally comprises processing these electrical signals to produce the radiographic image, for example in the form of a video image or the like.

In a preferred embodiment, the method also comprises a stage which consists of filtering the electrical signals in dependence on predetermined criteria, for example, but not in a limiting manner, to eliminate the electrical signals which correspond to the images of the soft tissues of the gum or materials such as amalgams or the like, with the aim of only retaining the electrical signals which correspond to the images of the dentine.

These last signals may then be amplified according to a predetermined function, linear or not, to have, for example, only a

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portion of the image of the dentine dilated so that the dental practitioner can effect a more precise analysis of the state of the X-rayed tooth.

The method, the stages of which have been described above, is advantageously accomplished with an apparatus, the basic diagram of which is illustrated in the single Figure.

The apparatus, illustrated schematically in the single Figure, comprises an X-ray source 1, which is capable of emitting a bundle 2 of X-rays from an outlet aperture 3. This X-ray source 1 is capable of being positioned so that its outlet aperture is directed towards a tooth 4 and its surrounding area 5.

The apparatus also comprises a plurality of cylindrical rods 10, which are produced from a material capable of transforming the X-rays into light rays 11 of a wavelength greater than that of the X-rays.

Each rod comprises an inlet face 12, which is capable of receiving the X-rays from the bundle 2 after they have traversed the tooth 4 and its environment 5, and an outlet face, which is capable of emitting the light rays 11. These cylindrical rods 10 are disposed side by side so that all of the inlet faces 12 are turned towards the outlet aperture 3 of the X-ray source 1.

In an advantageous embodiment, the cylindrical rods 10 are produced in a caesium iodide crystal and have a substantially cylindrical revolving configuration, with a length of between 80 and 200 μm , preferably between 100 and 120 μm , for a diameter of between 3 and 7 μm , preferably between 4 and 6 μm .

In addition, it is certainly advantageous that, as illustrated in the single Figure, these cylindrical rods are in contact with one another to form in some manner a mosaic, the thickness of which is equal to the length of a rod.

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The apparatus according to the invention has an essential advantage over previous apparatuses of the same type: the construction and the disposition of the cylindrical rods 10, such as described above, permit the X-rays, which penetrate into these rods through their inlet face 12, to be perfectly guided. The result is only a very weak dispersal of X-rays into the surrounding space, and this permits virtually all of the X-rays, which have traversed the tooth and its surrounding area, to be transformed into light rays, and hence permits the sensitivity of the apparatus to be increased very substantially as compared with apparatuses of the same type from known prior art.

The apparatus also comprises means 20 for converting the light rays 11 into electrical signals.

In a preferred embodiment, these means 20 comprise a converter 21 for converting light rays into analogue electrical signals and a converter 22 for converting analogue electrical signals into digital electrical signals, the inlet 23 of which latter converter is connected to the outlet 24 of the analogue converter 21.

Advantageously, the analogue converter 21 is formed by a CCD bar, while the digital converter 22 is a CAN converter of the type which has at least twelve bits. Alternatively, the analogue converter may be formed by a CMOS bar.

Of course, the apparatus comprises means 30 for connecting the outlet faces 13 of the cylindrical rods 10 to the photosensitive faces 25 of the analogue converter 21. These connecting means 30 may be formed by means for positioning the photosensitive faces 25 opposite outlet faces 13 of the rods. However, with an aim to design an easily manipulative apparatus, it may be advantageous for these connecting means 30 to be formed by a bundle of optical fibres, as schematically

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illustrated by 31 in the Figure, the inlet faces of the optical fibres being positioned opposite the outlet faces 13 of the rods,, and their outlet faces being disposed opposite the photosensitive faces 25 of the converter 21.

Advantageously, in order to adapt the use of the apparatus more to the wishes of dental practitioners, the apparatus comprises controllable means 40 for filtering the electrical signals obtained at the outlet of the means 20 defined above, that is to say, in the embodiment schematically illustrated in the Figure, at the outlet 26 of the CAN digital converter 22.

The apparatus may have a single filter, the passing band of which may be adapted to the wishes of the practitioner.

As illustrated, this filter may advantageously be equivalent to an assembly, for example, of three filters. By way of example: a "low-pass" filter 41, a "band-pass" filter 42 and a "high-pass" filter 43.

The low-pass filter 41 is, for example, capable of eliminating the electrical signals generated by the X-rays after they have traversed the most opaque parts of the tooth 4 and its surrounding area 5, such as a cavity of the tooth filled with an amalgam or the like, a post and core planted in a root, etc.

The band-pass filter 42 is, for example, capable of only allowing the electrical signals generated by the X-rays to pass therethrough after they have traversed the dentine of the tooth 4 and the material parts of its surrounding area 5 substantially equivalent to the dentine.

The high-pass filter 43 is, for example, capable of eliminating the electrical signals generated by the X-rays after they have traversed the soft tissues or the like of the tooth and its surrounding area, for example the flesh of the gum.

Alternatively, said means 40 for filtering the electrical signals comprise at least one of the following three filters: a low-pass filter 41,

which is capable of eliminating the electrical signals corresponding to the X-rays after they have traversed the most opaque parts of said tooth 4 and its surrounding area 5, a band-pass filter 42, which is capable of allowing the electrical signals corresponding to the X-rays to pass therethrough after they have traversed the dentine of the tooth and the material parts of its surrounding area substantially equivalent to this dentine, and a high-pass filter 43, which is capable of eliminating the electrical signals corresponding to the X-rays after they have traversed soft tissues or the like of the tooth and its surrounding area.

In addition, in an advantageous embodiment, the apparatus comprises means 50 for amplifying the electrical signals issued by the means 20 for converting the light rays 11 into electrical signals.

In the example illustrated, these amplification means 50 are formed by three controllable amplifiers 51, 52 and 53, the inlets of which are respectively connected to the outlets of the three filters 41, 42 and 43.

In this manner, the signals obtained at the outlet 44 of the filter means 40 may be amplified according to a predetermined function, for example linear to obtain a homothetic image, without distortion, of the radiographic image of the tooth 4 and its surrounding area 5. But it may be advantageous to select a non-linear function in order to obtain a magnifying effect on a selected portion of the radiographic image, with the aim of effecting a more precise analysis of the state of that portion.

Of course, the assembly of the three filters 41-43 and the three amplifiers 51-53 is advantageously directed by a control unit 60 of the computer or analogue type.

Finally, the apparatus comprises means 70 for processing the electrical signals obtained, in the illustrated example, at the outlet 71 of the amplifiers 51-53, with a view to producing the radiographic image of

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the tooth and its surrounding area. These means 70 for processing electrical signals may be of different types, for example made up of temporary or permanent memories or generally of a converter for converting electrical signals into video signals which are capable of being displayed on the screen of a monitor.

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CLAIMS

1. Method of obtaining a radiographic image of a tooth and of its surrounding area, characterised in that it comprises:

emitting a bundle of X-rays in the direction of said tooth and its surrounding area,

guiding the X-rays, which emerge from said tooth and its surrounding area, in substantially cylindrical volumes substantially along the axis of said volumes,

transforming the X-rays, when they are guided in said cylindrical volumes, into light rays of a greater wavelength than that of the X-rays,

converting these light rays into electrical signals, and

processing these electrical signals to produce said radiographic image.

2. Method according to claim 1, characterised in that it also comprises filtering said electrical signals in dependence on predetermined criteria.

3. Method according to one of the preceding claims, characterised in that said light rays are converted into analogue electrical signals, and in that these said analogue electrical signals are converted into digital electrical signals.

4. Method according to one of the preceding claims, characterised in that it comprises amplifying at least one portion of said electrical signals according to a predetermined function.

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5. Apparatus for accomplishing the method according to one of the preceding claims, characterised in that it comprises:

a source (1), which is capable of emitting a bundle of X-rays towards said tooth (4) and its surrounding area (5),

a plurality of cylindrical rods (10), which are produced from a material capable of transforming the X-rays into light rays (11) of a wavelength greater than that of the X-rays, each rod comprising an inlet face (12), which is capable of receiving said X-rays, and an outlet face (13), which is capable of emitting said light rays (11), said cylindrical rods (10) being disposed side by side so that all of the inlet faces (12) are turned towards said X-ray source (1),

means (20) for converting light rays (11) into electrical signals,

means (30) for connecting the outlet faces (13) of the cylindrical rods to said means (20) for converting light rays into electrical signals, and

means (70) for processing said electrical signals with a view to producing said radiographic image.

6. Apparatus according to claim 5, characterised in that the means (20) for converting light rays into electrical signals comprise a converter (21) for converting light rays into analogue electrical signals and a converter (22) for converting analogue electrical signals into digital electrical signals, the inlet (23) of which latter converter is connected to the outlet (24) of the converter for converting light rays into analogue electrical signals.

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7. Apparatus according to claim 6, characterised in that said converter (21) for converting light rays into analogue electrical signals is formed by a CCD bar, and in that said converter (22) for converting analogue electrical signals into digital electrical signals is a CAN converter of the type which has at least twelve bits.

8. Apparatus according to one of claims 5 to 7, characterised in that it also comprises means (40) for filtering said electrical signals.

9. Apparatus according to claim 8, characterised in that said means (40) for filtering the electrical signals comprise at least one of the following three filters: a low-pass filter (41), which is capable of eliminating the electrical signals corresponding to the X-rays after they have traversed the most opaque parts of said tooth (4) and its surrounding area (5), a band-pass filter (42), which is capable of allowing the electrical signals corresponding to the X-rays to pass therethrough after they have traversed the dentine of the tooth and the material parts of its surrounding area substantially equivalent to this dentine, and a high-pass filter (43), which is capable of eliminating the electrical signals corresponding to the X-rays after they have traversed soft tissues or the like of the tooth and its surrounding area.

10. Apparatus according to claim 9, characterised in that it also comprises means (50) for amplifying the electrical signals obtained at the outlet (44) of at least one of the three filters (41-43), according to a predetermined function.

11. Apparatus according to one of claims 5 to 10, characterised in that the means (70) for processing said electrical signals with a view to producing said radiographic image comprise at least one of the following elements: a temporary memory, a permanent memory or a converter for converting electrical signals into video signals which are capable of being displayed on a screen.

12. Apparatus according to one of claims 5 to 11, characterised in that said cylindrical rods (10) are produced from caesium iodide crystal.

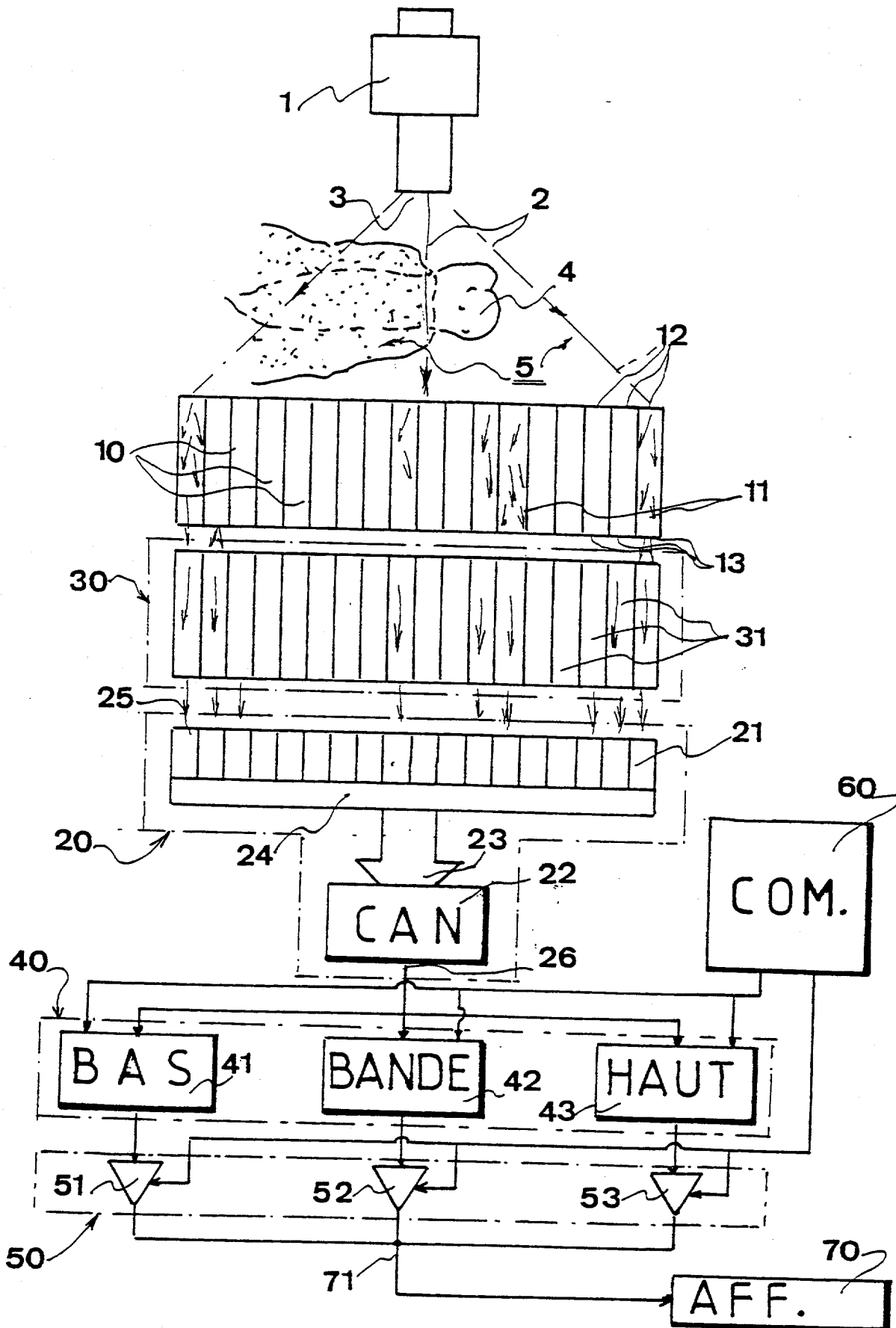
13. Apparatus according to claim 12, characterised in that said cylindrical rods (10) have a substantially cylindrical revolving configuration, with a length of between 80 and 200 μm , for a diameter of between 3 and 7 μm .

14. Apparatus according to one of claims 5 to 13, characterised in that said cylindrical rods (10) are in contact with one another to form a mosaic.

15. Apparatus according to one of claims 5 to 14, characterised in that the means (30) for connecting the outlet faces (13) of the cylindrical rods (10) to said means (20) for converting light rays into electrical signals comprise a bundle of optical fibres.

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**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT AND DESIGN APPLICATIONS**

ATTORNEY DOCKET NO.
0559-0110P

PLEASE NOTE:
YOU MUST
COMPLETE THE
FOLLOWING:

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:*

Insert Title

Method for Obtaining a radiographic image of a tooth and its surrounding environment, and devices implementing said method

Check Box If
Appropriate -
For Use Without
Specification
Attached

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States Application Number _____ or PCT International Application Number PCT/FR00/02398 and was amended on 14 September 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof, or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Insert Priority
Information
(if appropriate)

			Prior	Claimed
99 10911	FRANCE	AUGUST 30, 1999	<input checked="" type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
(Number)	(Country)	(Month/Day/Year Filed)	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
(Number)	(Country)	(Month/Day/Year Filed)	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
(Number)	(Country)	(Month/Day/Year Filed)	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number)

(Filing Date)

(Application Number)

(Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months (6 Months for Designs) Prior To The Filing Date of This Application:

Country

Application No.

Date of Filing (Month/Day/Year)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)

(Filing Date)

(Status — patented, pending, abandoned)

(Application Number)

(Filing Date)

(Status — patented, pending, abandoned)

Must be completed.

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

PLEASE NOTE:
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FOLLOWING:

Send Correspondence to: BIRCH, STEWART, KOLASCH & BIRCH, LLP
Intellectual Property Law
8110 Gatehouse Road, Suite 500 East
Falls Church, VA 22042-1210
USA

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Sole
Inventor:

Insert Name of Inventor
Insert Date This
Document is Signed

Insert Residence
Insert Citizenship

Insert Post Office
Address

Full Name of Second
Inventor, if any:

see above

Full Name of Third
Inventor, if any:

see above

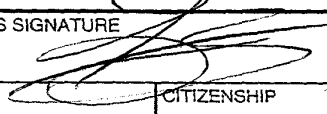
Full Name of Fourth
Inventor, if any:

see above

Full Name of Fifth
Inventor, if any:

see above

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on this document is
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GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
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GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
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